



# Bio-Rad Gene Pulsar Xcell™ Electroporation System

Bergen County Technical Schools  
**Biotechnology Lab**





### **Bio-Rad Gene Pulsar Xcell™ Electroporation System Information Sheet**

The Bio-Rad Gene Pulsar Xcell™ Electroporation System is a pulse generator that uses capacitors to produce controlled exponential or square wave electrical pulses for cell electroporation. The unit is capable of producing pulses of up to 3000V on a high-voltage circuit, and up to 500V on a low-voltage circuit. The system is comprised of a main unit and two accessory modules, the CE and PC module, a shock chamber, and a cuvette with incorporated electrodes.

The CE module on the instrument is recommended to be used with the main unit for electroporation of most eukaryotic cells, including mammalian cells and plant protoplasts. The PC module is recommended for electroporation of bacteria and fungi (A list of commonly used cells and the settings that can be used in electroporation for those cells can be found on the next page). Both the PC and CE units have integral leads that connect to the main unit and both units are controlled directly from the user interface on the front panel of the main unit.

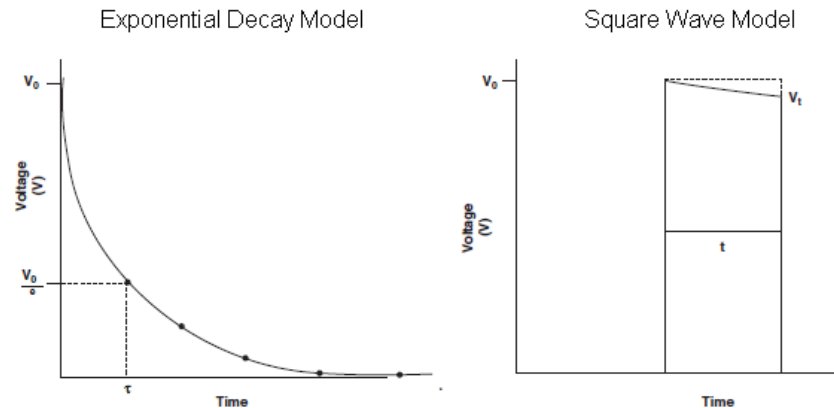
### **Overview of Electroporation Theory**

Electroporation is a physical process in which cells are exposed to a high-voltage electric field resulting in a temporary rearrangement of the cell membrane. As a result, the cells become permeable and may take up solutes from their surrounding environments, including nucleic acids, proteins, carbohydrates, and small molecules.

The instrument is capable of delivering both exponential decay and square wave pulses. An exponential decay pulse is a single pulse of electricity into the sample. The sample will start at a high voltage, and the voltage will decrease, or decay, over the course of the pulse. A square wave pulse on the other hand delivers multiple pulses, with each one being the same voltage (See image on the next page).

Activating the pulse button on the instrument charges the capacitors in the unit to a high voltage. The instrument then discharges the current in the capacitor into the

sample in the cuvette. The changes the cell experiences after electroporation can be explained by 2 parameters: the electric field applied and the length of time the sample is exposed to the field.



| Pre-set Protocol Designation | Cells         | Pulse type        | PL (msec) | C ( $\mu$ F) | PC (ohm) | V    | Cuvette (cm) | Cell vol ( $\mu$ l) |
|------------------------------|---------------|-------------------|-----------|--------------|----------|------|--------------|---------------------|
| Mammalian 1                  | CHO           | Square wave       | 15        |              |          | 160  | 0.2          | 100                 |
| Mammalian 2                  | COS7          | Square wave       | 20        |              |          | 110  | 0.2          | 100                 |
| Mammalian 3                  | 3T3           | Exponential decay |           | 500          | $\infty$ | 160  | 0.2          | 100                 |
| Mammalian 4                  | 293           | Square wave       | 25        |              |          | 110  | 0.2          | 100                 |
| Mammalian 5                  | HeLa          | Exponential decay |           | 500          | $\infty$ | 160  | 0.2          | 100                 |
| Mammalian 6                  | BHK21         | Square wave       | 25        |              |          | 140  | 0.2          | 100                 |
| Mammalian 7                  | A549          | Square wave       | 10        |              |          | 150  | 0.2          | 100                 |
| Mammalian 8                  | CV1           | Square wave       | 25        |              |          | 100  | 0.2          | 100                 |
| Mammalian 9                  | K562          | Exponential decay |           | 1000         | $\infty$ | 155  | 0.2          | 100                 |
| Mammalian 10                 | HL60          | Square wave       | 25        |              |          | 140  | 0.2          | 100                 |
| Mammalian 11                 | Jurkat        | Exponential decay |           | 1000         | $\infty$ | 140  | 0.2          | 100                 |
| Mammalian 12                 | HuT78         | Square wave       | 25        |              |          | 130  | 0.2          | 100                 |
| Bacterial 1                  | E coli        | Exponential decay |           | 25           | 200      | 1800 | 0.1          | 20                  |
| Bacterial 2                  |               |                   |           | 25           | 200      | 2500 | 0.2          | 20–40               |
| Bacterial 3                  |               |                   |           | 25           | 200      | 3000 | 0.2          | 20–40               |
| Bacterial 4                  | A tumefaciens | Exponential decay |           | 25           | 200      | 2400 | 0.1          | 20                  |
| Bacterial 5                  | P aeruginosa  | Exponential decay |           | 25           | 200      | 2500 | 0.2          | 100                 |
| Bacterial 6                  | S aureus      | Exponential decay |           | 25           | 100      | 2900 | 0.2          | 50                  |
| Bacterial 7                  | B cereus      | Exponential decay |           | 50           | 200      | 1000 | 0.2          | 100                 |
| Bacterial 8                  | S pyogenes    | Exponential decay |           | 25           | 200      | 2100 | 0.2          | 200                 |
| Bacterial 9                  | L plantarum   | Exponential decay |           | 25           | 400      | 2000 | 0.2          | 40                  |
| Fungal 1                     | S cerevisiae  | Exponential decay |           | 25           | 200      | 1500 | 0.2          | 40                  |
| Fungal 2                     |               |                   |           | 25           | 200      | 2500 | 0.4          | 80                  |
| Fungal 3                     | S pombe       | Exponential decay |           | 25           | 200      | 2300 | 0.2          | 40                  |
| Fungal 4                     | C albicans    | Exponential decay |           | 25           | 200      | 1500 | 0.2          | 40                  |
| Fungal 5                     | P pastoris    | Exponential decay |           | 25           | 200      | 2000 | 0.2          | 40                  |
| Fungal 6                     | D discoideum  | Square wave       | 1.0       | 10           |          | 1000 | 0.4          | 800 2 pulses        |



## Bio-Rad Gene Pulsar Xcell™ Electroporation System Quick Start Guide

### Starting up the instrument

1. Turn on the Bio-Rad Gene Pulsar Xcell™ Electroporation System by pressing the **Power Button** located on the right side of the instrument's main unit.

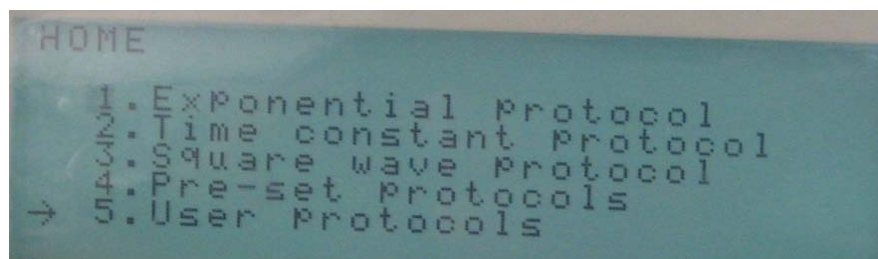


- a. The instrument will go through a start-up procedure once it is powered on. A green light will also appear on the front of the instrument.



**Note:** There is not a computer or external software associated with this instrument. Once the initial start-up is complete, all operations are controlled via the **Instrument Controls** and **LCD Screen** of the instrument.

2. Once the instrument is ready to use, the *Home Screen* will appear on the **LCD Screen**.

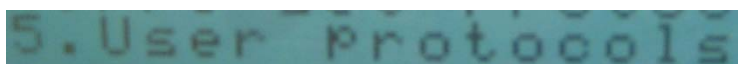


**Note:** Since no computer is associated with the instrument, all electroporation parameters and samples should be recorded by the user and kept in their research notebook.

## Creating a User Name

Note: A user name is not necessary if the user is going to perform a single electroporation. If the user is going to be creating multiple protocols that will be used on samples, or plans to repeat the protocol, a user name should be created.

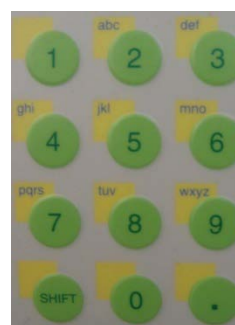
1. To create a new user name, press **5** on the *Home Screen*, or press the down keys to move to “**User Protocols**”. Press **Enter**.



2. Using the **Arrow Keys**, move to a position on the list with no name next to a number. Press **Enter** to select that position.



3. Use the **Alpha-numeric Keypad** to type in the desired user name. The name can have up to 10 characters.



4. Press the **Save Button** once the name has been entered. This will save the user name into the instrument's memory.

## Sample Information

- Electroporation cuvettes are used to hold the sample.
- The cuvette should not be filled with more than 1mL (1000µL) of liquid.
- The cuvette should sit in the Shockpod with the frosted sides to the left and right, and the slit where the sample can be seen facing the front of the Shockpod.
- Once the sample is prepared, placed in the cuvette, and placed in the Shockpod, close the lid to the Shockpod and continue with setting up the electroporation protocol.

## Creating and Using an Exponential Decay Protocol

1. On the *Home Screen*, use the arrow keys to move to **1** for **Exponential Protocol**. Press **Enter**.



1.Exponential Protocol

- a. On the next screen, the user will be able to enter:
    - i. The **Voltage** for the pulse (in V).
    - ii. The **Capacitance** for the pulse (in  $\mu\text{F}$ ).
    - iii. The **Resistance** for the pulse (in ohm).
2. Use the **Alpha-numeric Keypad** to enter the values for each of those settings.
    - a. The user does not need to enter a value for the cuvette in mm.

Voltage(V)  
Capacitance( $\mu\text{F}$ )  
Resistance( $\Omega$ )  
Cuvette(mm)

**Note:** Below is a guide for when certain capacitance and voltage settings should be used.

|            | Capacitance ( $\mu\text{F}$ ) | Voltage (V)               |                           |
|------------|-------------------------------|---------------------------|---------------------------|
|            |                               | $R_{\text{sample}} < 600$ | $R_{\text{sample}} > 600$ |
| HV Circuit | 10 – 50                       | 200 – 2500                | 200 – 3000                |
| LV Circuit | 25 – 3275                     | 10 – 500                  | 10 – 500                  |

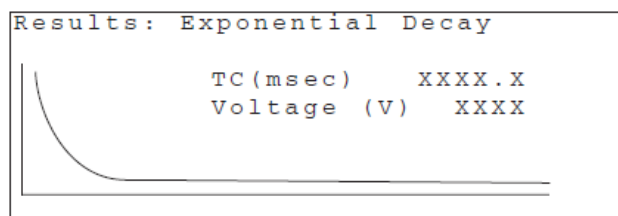
3. Once all information is entered, a flashing “**P**” will appear in the lower right corner of the LCD Screen indicating a pulse may be delivered to the sample.



4. Press the **Pulse Button** on the instrument to deliver the pulse to the **Shockpod**.



- a. The screen will show “**Pulsing**” when the pulse is being delivered.
5. Upon completion, a tone will sound and the pulse measurements will be displayed in the **Protocol Results Screen**.



6. From this point, another pulse can be repeated, or the protocol can be saved if necessary by following the directions in the setting “**Saving a User Created Protocol**”.

### Creating and Using an Exponential Decay Protocol with a Time Constant

1. On the *Home Screen*, use the arrow keys to move to **2** for **Time Constant Protocol**. Press **Enter**.

ENTER

2. Time constant Protocol

- a. On the next screen, the user will be able to enter:
  - i. The **Voltage** for the pulse (in V).
  - ii. The **Time Constant** for the pulse (in msec).
  - iii. The instrument will automatically determine the resistance in this setting.
2. Use the **Alpha-numeric Keypad** to enter the values for each of those settings.
  - a. The user does not need to enter a value for the cuvette in mm.

Voltage (V)  
TC (ms)  
Cuvette (mm)

**Note:** Below is a guide for when certain voltage settings should be used.



| Sample resistance                 | Time constant range (msec) |              |
|-----------------------------------|----------------------------|--------------|
|                                   | LV Circuit*                | HV Circuit** |
| 20 ohms                           | 0.5 – 65.5                 | 0.2 – 1.0    |
| 200 ohms                          | 5.0 – 655                  | 2.0 – 10     |
| >1000 ohms                        | 25 – 3275                  | 10 – 50      |
| * LV Circuit range: 10 – 500 V    |                            |              |
| ** HV Circuit range: 200 – 3000 V |                            |              |

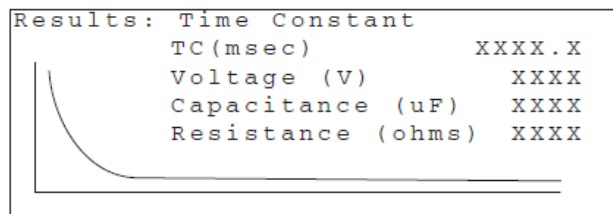
3. Once all information is entered, a flashing “P” will appear in the lower right corner of the LCD Screen indicating a pulse may be delivered to the sample.



4. Press the **Pulse Button** on the instrument to deliver the pulse to the **Shockpod**.



- a. The screen will show “Pulsing” when the pulse is being delivered.
5. Upon completion, a tone will sound and the pulse measurements will be displayed in the **Protocol Results Screen**.



6. From this point, another pulse can be repeated, or the protocol can be saved if necessary by following the directions in the setting “**Saving a User Created Protocol**”.

### Creating and Using a Square Wave Protocol

1. On the *Home Screen*, use the arrow keys to move to **3** for **Square Wave Protocol**. Press **Enter**.

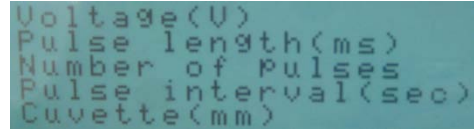


3. Square wave protocol



a. On the next screen, the user will be able to enter:

- i. The **Voltage** for the pulse (in V).
- ii. The **Pulse Length** (in msec).
- iii. The **Number of Pulses**.
- iv. The **Pulse Interval** (in sec).



```
Voltage(V)
Pulse length(ms)
Number of pulses
Pulse interval(sec)
Cuvette(mm)
```

2. Use the **Alpha-numeric Keypad** to enter the values for each of those settings.

a. The user does not need to enter a value for the cuvette in mm.

**Note:** Below is a guide for when certain capacitance and voltage settings should be used.

|             | Voltage (V) | Pulse Length | Pulse Interval | No. Pulses (max) |
|-------------|-------------|--------------|----------------|------------------|
| LV Circuit* | 10–500      | 0.05–100 ms  | 0.1–10 s       | 10               |
| HV Circuit  | 200–3000    | 0.05–5 msec  | 5–30 s         | 2                |

3. Once all information is entered, a flashing “**P**” will appear in the lower right corner of the LCD Screen indicating a pulse may be delivered to the sample.

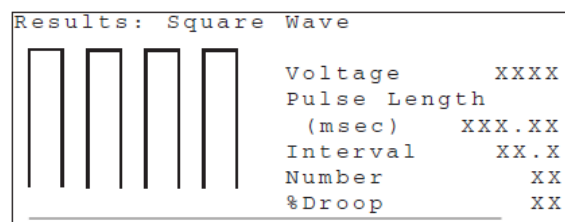


4. Press the **Pulse Button** on the instrument to deliver the pulse to the **Shockpod**.



a. The screen will show “**Pulsing**” when the pulse is being delivered.

5. Upon completion, a tone will sound and the pulse measurements will be displayed in the **Protocol Results Screen**.

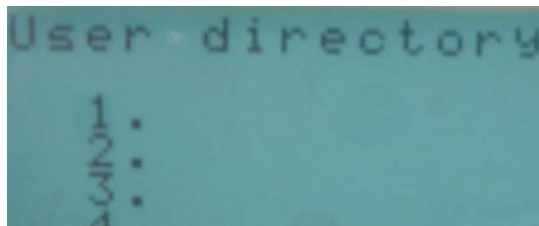


6. From this point, another pulse can be repeated, or the protocol can be saved if necessary by following the directions in the setting “**Saving a User Created Protocol**”.

### **Saving a User Created Protocol**

Note: If the protocol being used is only going to be run one time, it does not need to be saved. However, if the protocol might be used multiple times by the user, it should be saved into the user name directory just created.

1. When the protocol that was created is open, press the **Save Button** on the instrument.
2. The *User Directory* will appear on the screen. Use the arrow keys to select the user name that was created previously. Press **Enter**.



- a. If a user name was not previously created, refer back to the section “**Creating a User Name**”
3. On the next screen, use the arrow keys to move to a blank spot and press **Enter**.

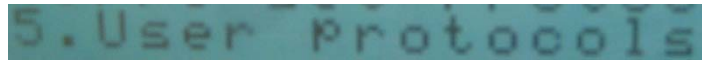


### **Using a Saved Protocol**


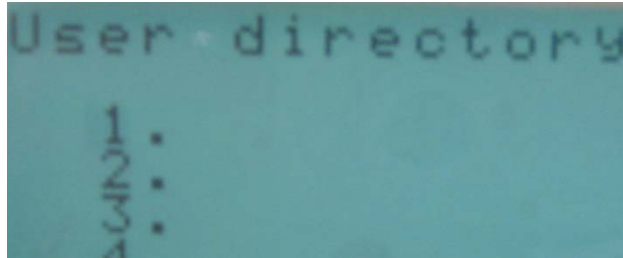
To use a protocol that was saved:

1. Use the **Arrow Keys** to move to **5** on the *Home Screen*. Press **Enter**.




A photograph of a handheld device's LCD screen. The screen is monochrome and displays the text "5. User Protocols" in a simple, pixelated font.

2. Use the **Arrow Keys** to move to the desired **User Name** in the list.  
Press **Enter**.

A blue rectangular button with the word "ENTER" in white capital letters.A photograph of a handheld device's LCD screen. The screen displays the text "User directory" at the top. Below it, a list of numbers is visible: "1.", "2.", "3.", and "4.". The numbers are aligned to the left.

3. Select the **Protocol**. Press **Enter**.

A blue rectangular button with the word "ENTER" in white capital letters.

4. Follow the directions from the previous sections for applying the pulse to the sample.

### **Using a Preset Protocol**

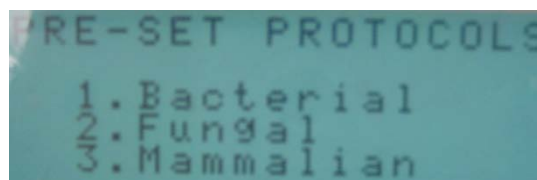
*Note: A list of preset protocols and conditions can be found on the second page of the Information Guide of this packet.*

To use a protocol that was preloaded in the instrument:

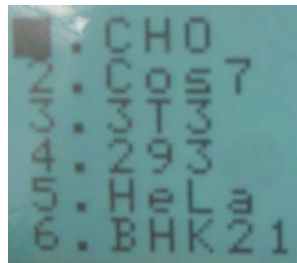
1. On the *Home Screen*, use the **Arrow Keys** to move to **4** for **Preset Protocols**, and press **Enter**.

A blue rectangular button with the word "ENTER" in white capital letters.A photograph of a handheld device's LCD screen. The screen displays the text "4. Pre-set Protocols" in a simple, pixelated font.

2. Depending on your sample, select from the following list and press **Enter**:

A blue rectangular button with the word "ENTER" in white capital letters.A photograph of a handheld device's LCD screen. The screen displays the text "PRE-SET PROTOCOLS" at the top. Below it, a list of options is visible: "1. Bacterial", "2. Fungal", and "3. Mammalian". The options are aligned to the left.

3. On the list of organism types, use the arrow keys to select the desired organism and press **Enter**.



4. Once all information is entered, a flashing "**P**" will appear in the lower right corner of the LCD Screen indicating a pulse may be delivered to the sample.



5. Press the **Pulse Button** on the instrument to deliver the pulse to the **Shockpod**.



- a. The screen will show "**Pulsing**" when the pulse is being delivered.
6. Upon completion, a tone will sound and the pulse measurements will be displayed in the **Protocol Results Screen**.

### **Shutting Down the Instrument**

1. Remove sample cuvette from the **Shockpod**.
2. Shut the **Power Off** by pressing the **Power Button** on the right side of the instrument.



- a. The **Green LED Light** on the front of the instrument will turn off.
- b. The **LCD Screen** will also turn **Black**.



3. **Make sure the station is neat before leaving the instrument!**



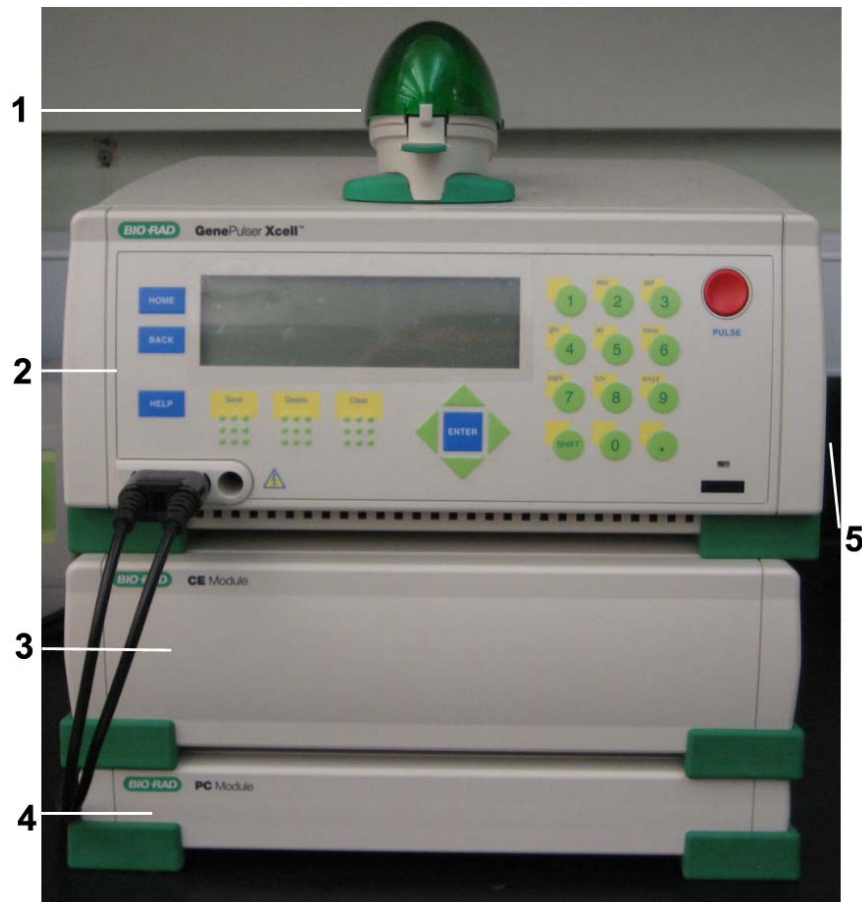
### **Bio-Rad Gene Pulsar Xcell™ Electroporation System Safety Sheet**

1. Samples should be handled according to good laboratory procedures and methods in order to prevent accidents.
2. When handling or dealing with chemicals or biological samples, be sure to wear appropriate protection (goggles, gloves, lab coat).
3. Dispose of all waste solutions according to waste disposal procedures.
4. Do not remove any panels or cords from the instrument to avoid electrical shock.
5. The instrument should not be used if obvious external case damage has occurred, or the electronic displays are not functioning.
6. Only use the Bio-Rad cables supplied with the instrument.
7. The instrument produces up to 3,000 Volts and is capable of passing very high currents. When charged to maximum voltage, the instrument stores about 400 Joules. The user should follow all directions to avoid any accidental electrical shocks.
8. The pulse button is active whenever the character space in the lower right corner is flashing. There is high voltage present whenever the pulse button is depressed and "Pulsing" is shown on the LCD display. The charge will dissipate over 1 – 2 minutes, but the user should still be aware of possible hazards.
9. The user should always wear safety glasses when pulsing a sample in a cuvette. The instrument has an arc-protection circuit that dramatically reduces the incidence of arcing in the cuvette, but eye protection should still be worn.
10. The instrument generates, uses, and radiates radio frequency energy which would could cause radio communication interruption if the instrument is not functioning normally.
11. If any liquid should fall near the instrument, do not operate the instrument. Fluid seepage into internal components creates a potential shock hazard, and can cause the instrument to not work properly.
12. Cleaning the workstation around the instrument is necessary. Never attempt to clean any internal spaces of the instrument.
13. Food and drinks should not be placed on or near the instrument.



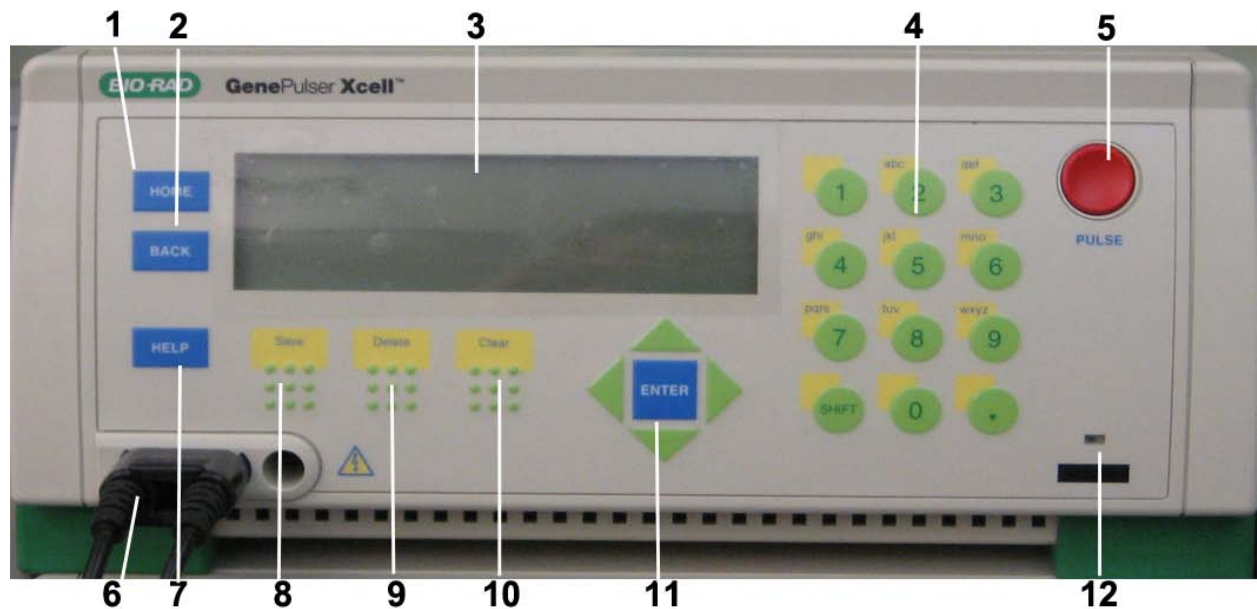
### Bio-Rad Gene Pulsar Xcell™ Electroporation System Instrument Information Sheet

#### Gene Pulsar Xcell™ Electroporation System Overview:



1. Electroporation Shockpod
2. Gene Pulse Xcell Main Unit
3. CE Module
4. PC Module
5. Power Button

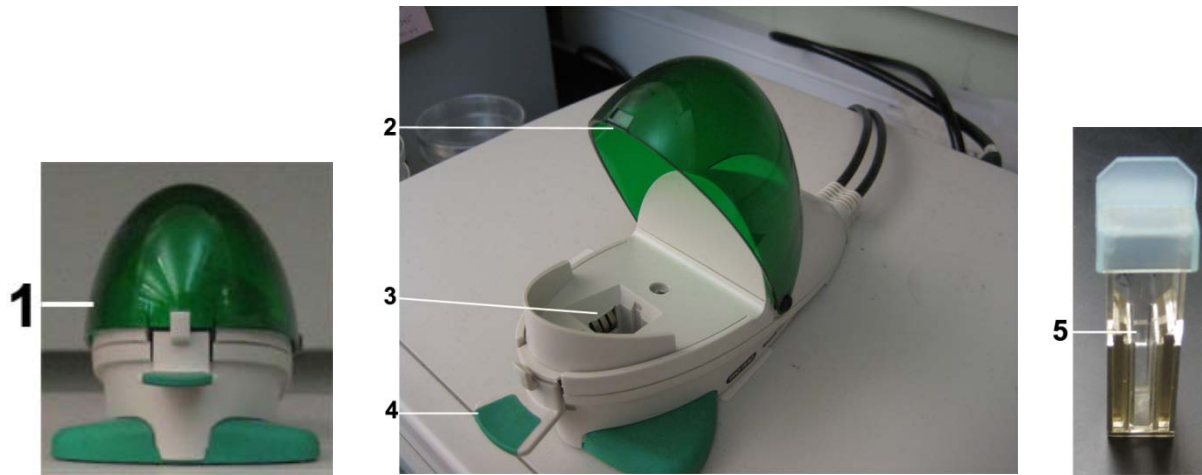
## Gene Pulse Xcell™ Main Unit Overview:



1. Home Button
2. Back Button
3. LCD Screen
4. Alpha-numeric Keypad
5. Pulse Button
6. Shockpod cables
7. Help Button
8. Save Button
9. Delete Button
10. Clear Button
11. Arrow Keys and Enter Button
12. Power On/Off Indicator LED



## Shockpod Overview:



1. Shockpod Unit Closed
2. Shockpod Lid
3. Cuvette Holder and Shock Region
4. Cover Open Tab
5. Electroporation Cuvette